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Whiddon et al.

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(54) **SUBSEA UMBILICAL SYSTEM WITH CABLE BREAKOUT**

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E21B 43/013 (2006.01)

(52) **U.S. Cl.**
CPC *E21B 43/013* (2013.01)

(58) **Field of Classification Search**
CPC E21B 43/013; F16L 1/26; F16L 39/00; H02G 15/14; H02G 9/12
USPC 166/339, 341, 343, 344, 347, 367, 368, 166/345, 350–352; 405/158, 169, 173; 285/120.1, 124.3, 913, 914
See application file for complete search history.

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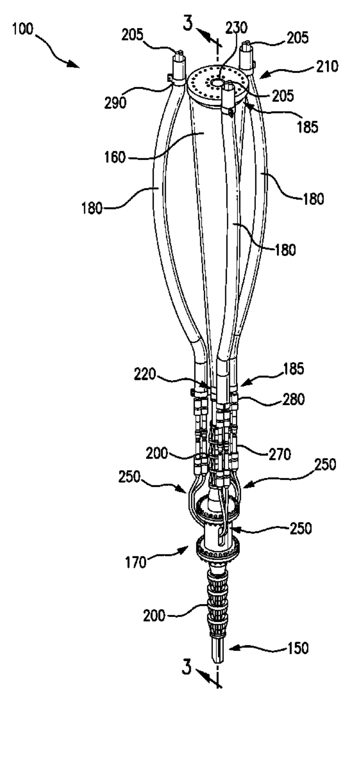
(57) **ABSTRACT**

A subsea umbilical system can be provided for connecting a topside structure at a proximal end of the system to subsea equipment at a distal end of the system. The system can include an umbilical configured to allow one or more cables for powering or communicating with subsea equipment to be passed through at least a portion of the umbilical. The system can further include reinforcing elements radially surrounding a portion of the umbilical. The system can further include a breakout box disposed along the umbilical and configured to be positioned between the reinforcing element and the subsea equipment. The breakout box can include a breakout opening configured to allow one or more breakout cables to exit the umbilical and run along the outside of the reinforcing elements to the topside structure. Related methods of making and using such systems are also described.

19 Claims, 12 Drawing Sheets



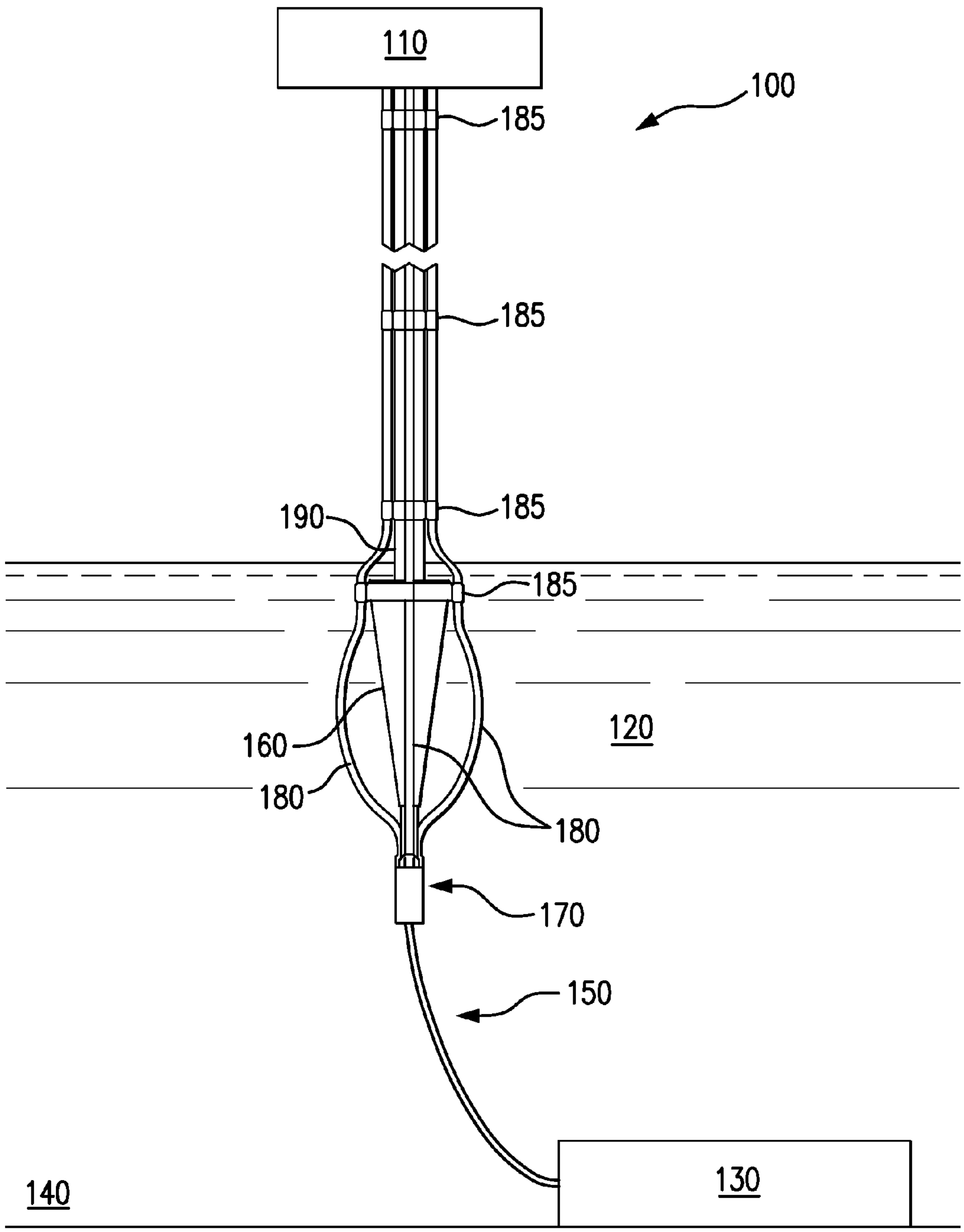
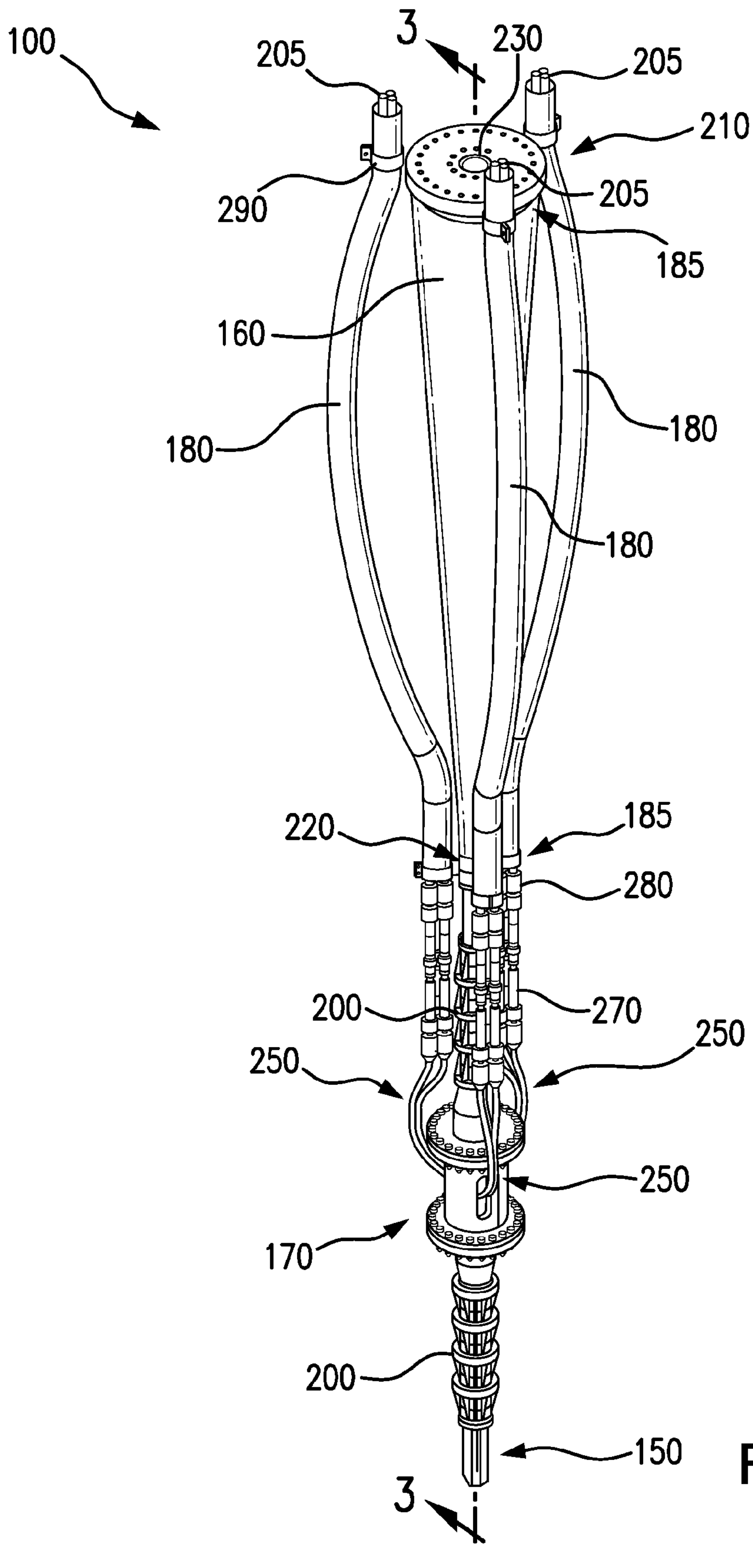


FIG. 1



100
3
230
205
205
210
290
205
185
160
180
180
180
180
220
185
280
200
270
250
250
250
170
200
150
3

FIG. 2

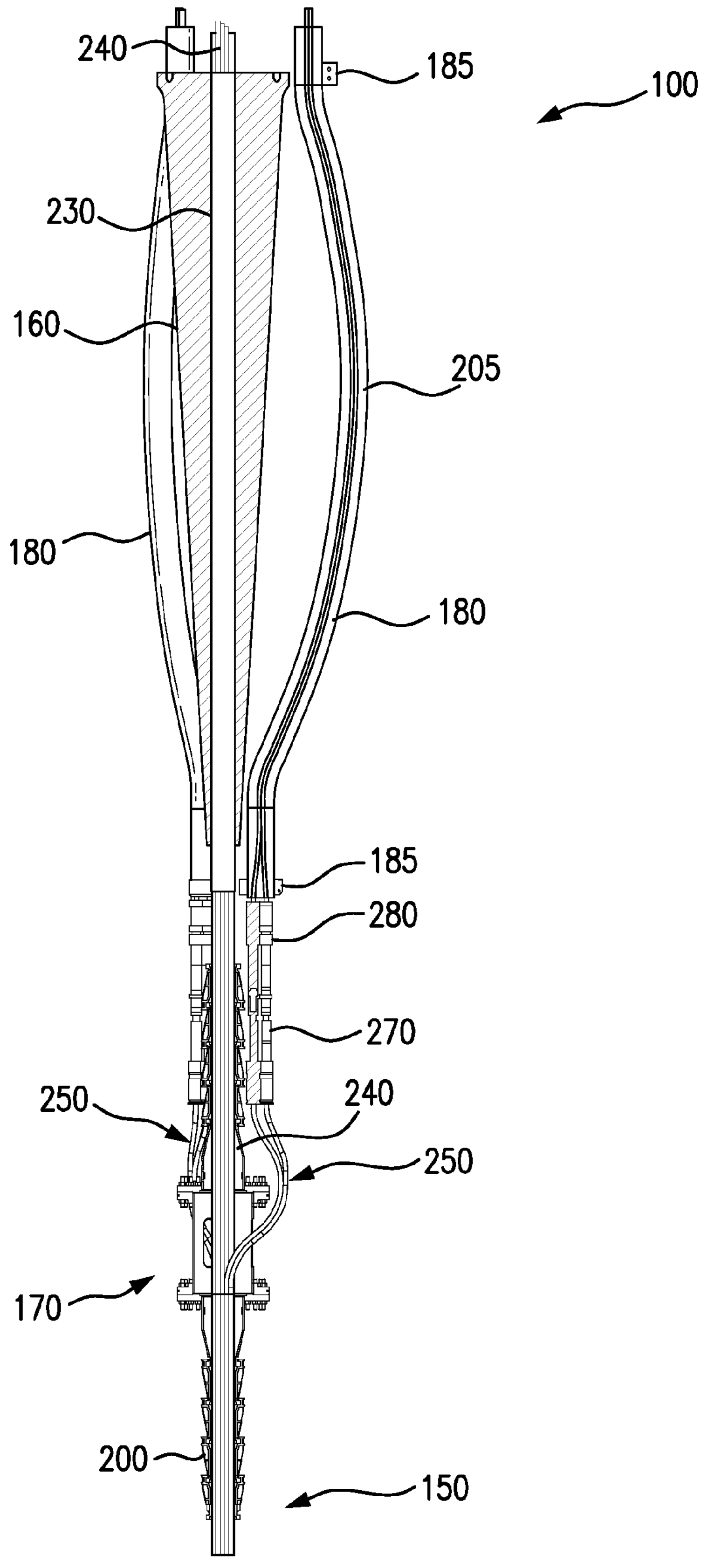

240
185
100
230
160
205
180
180
185
280
270
250
240
250
170
200
150

FIG. 3

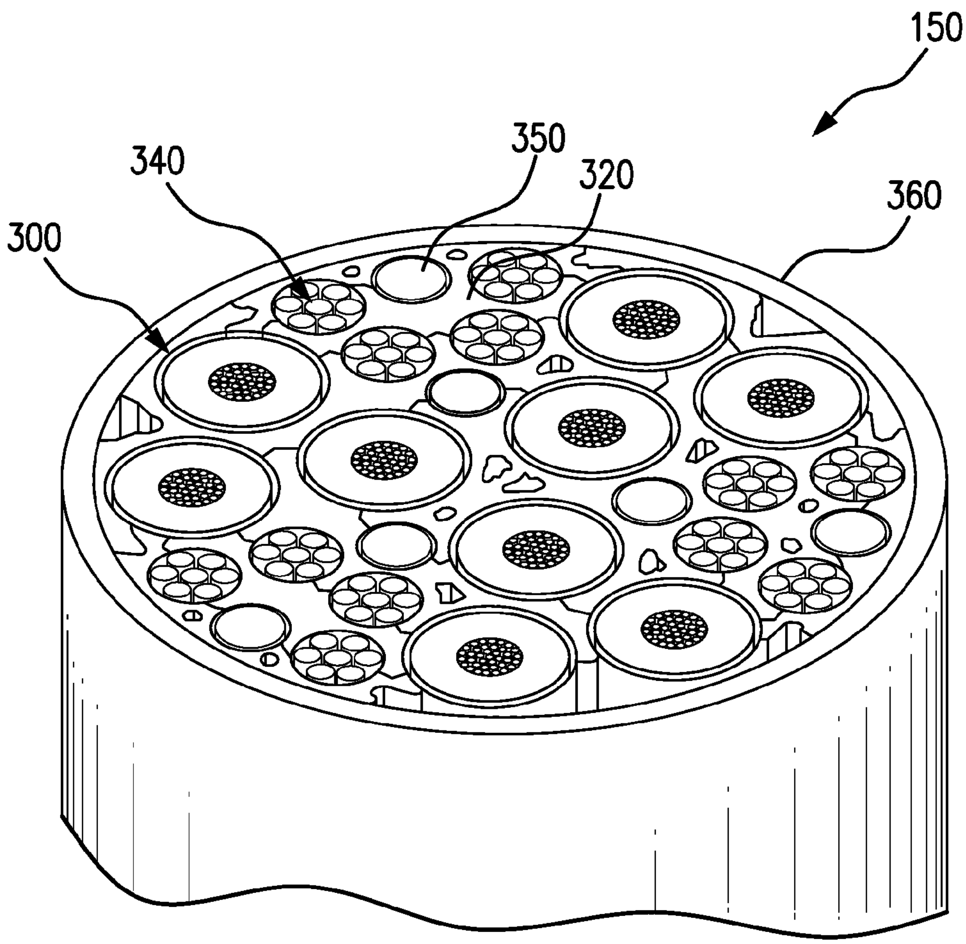


FIG. 4

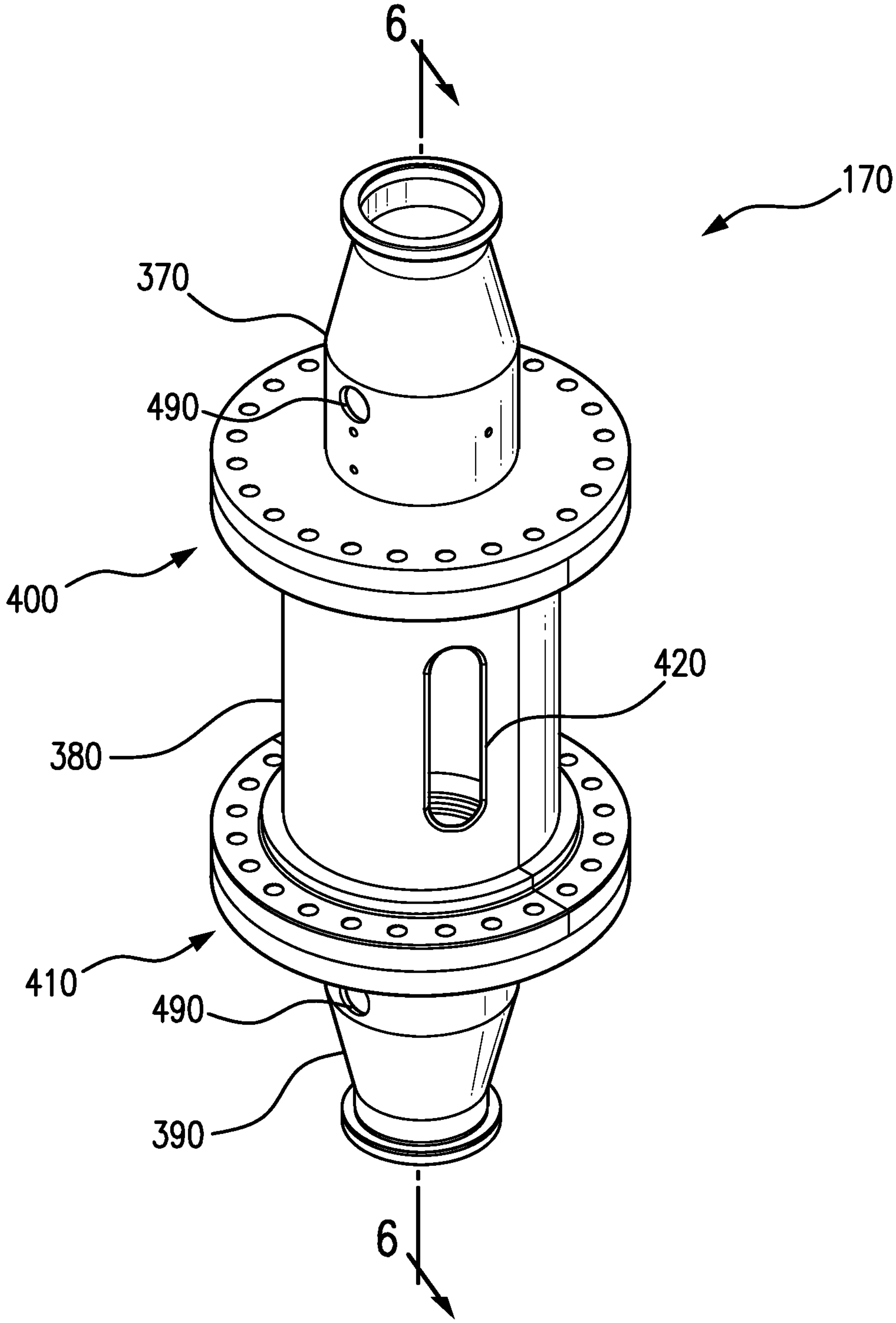


FIG. 5

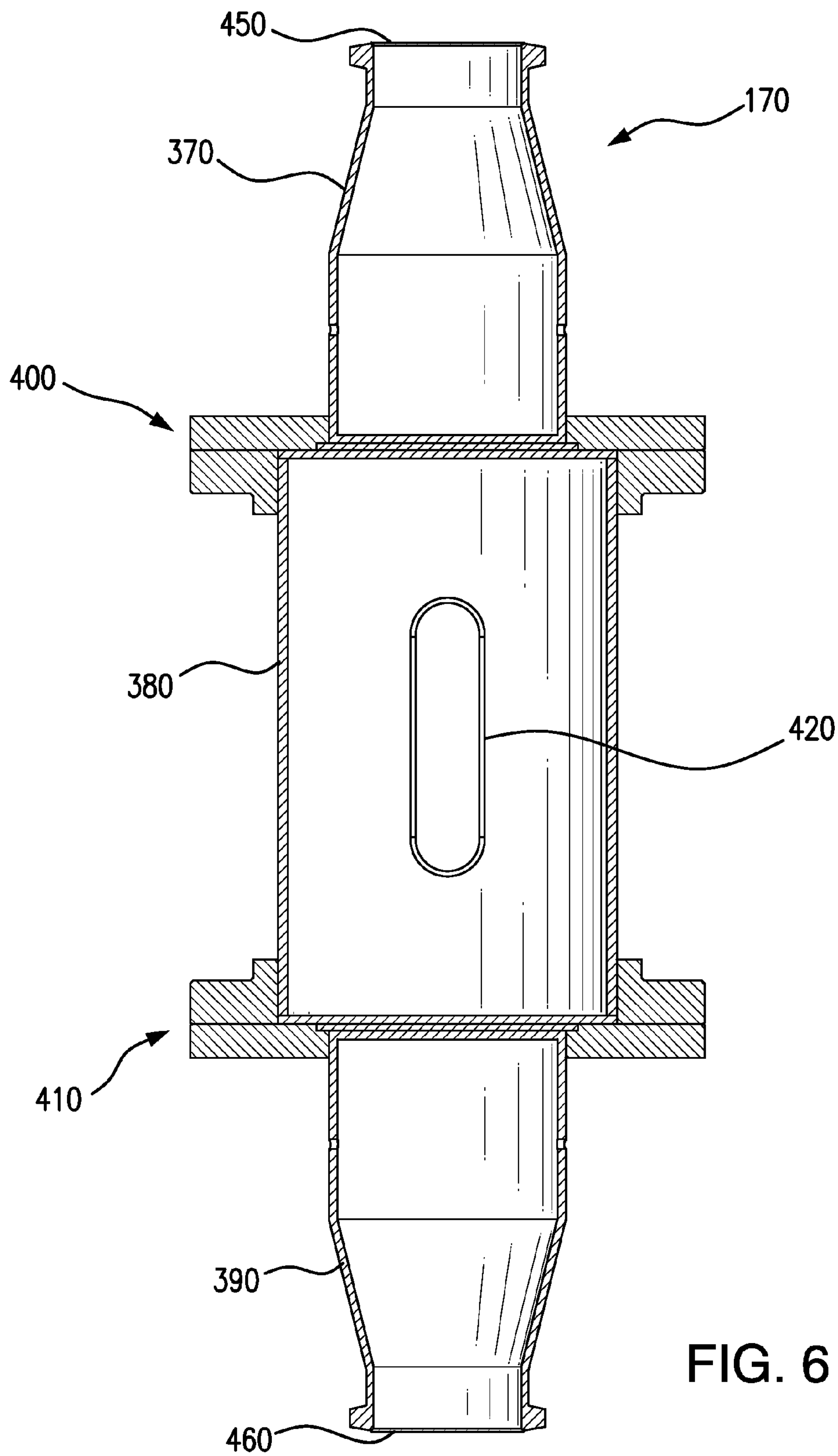


FIG. 6

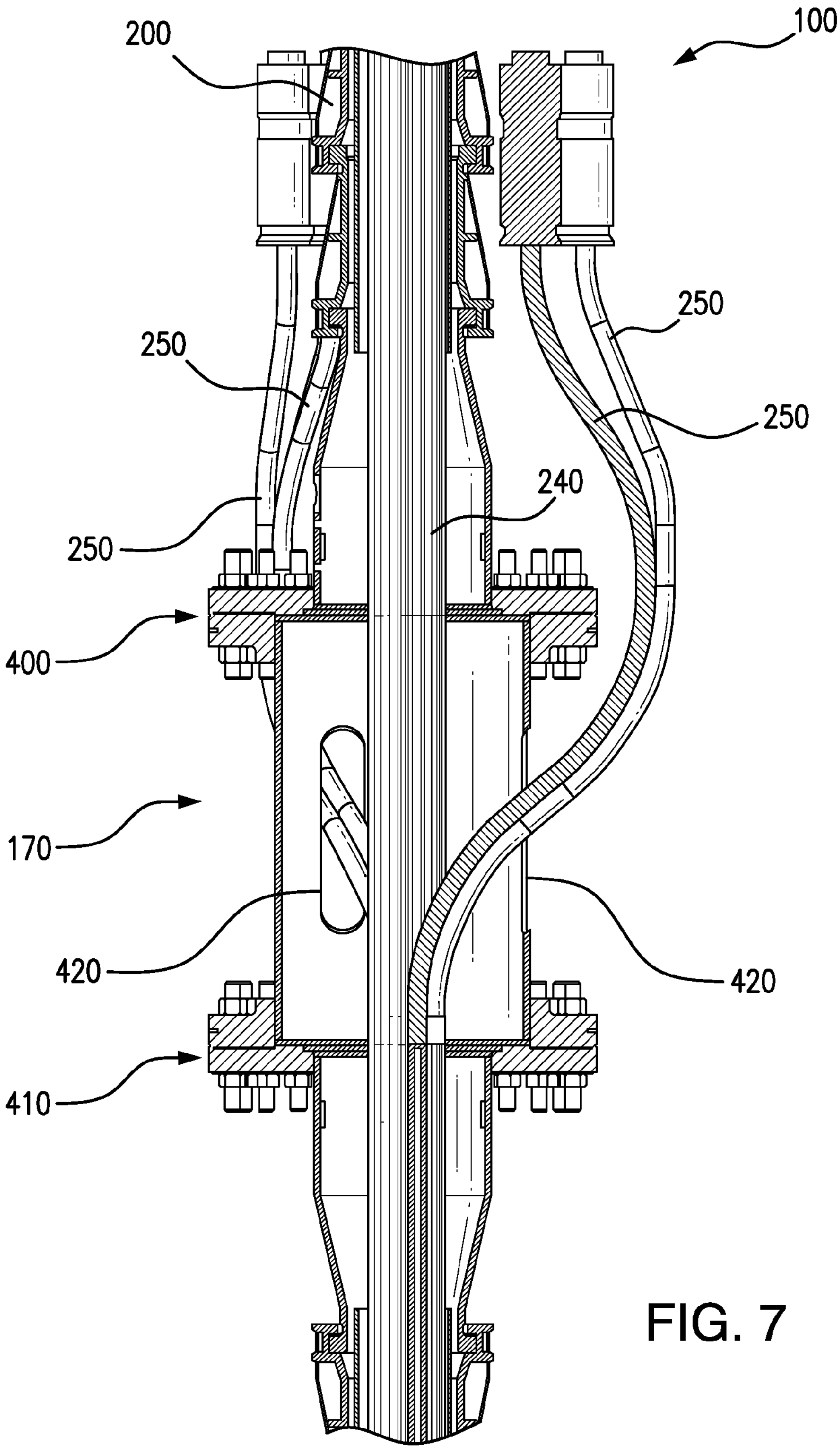
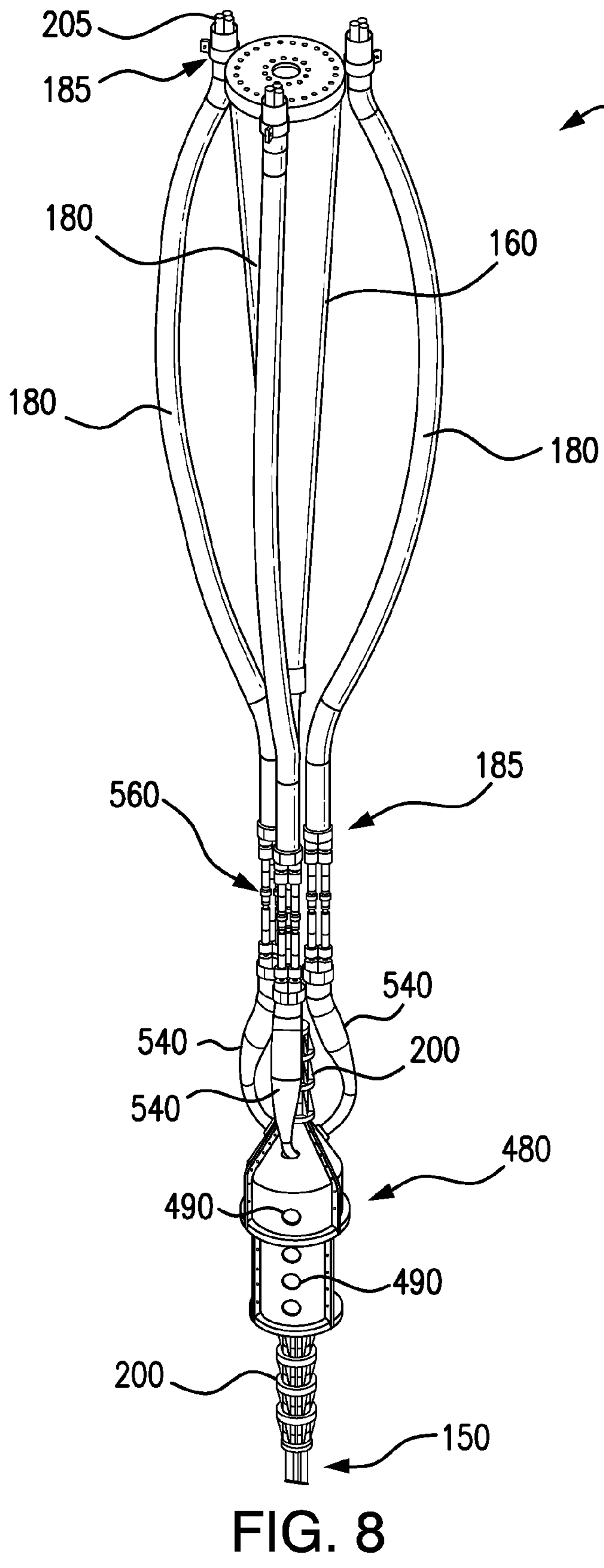


FIG. 7



205
185
470
180
160
180
180
560
185
540
540
200
540
480
490
490
200
150

FIG. 8

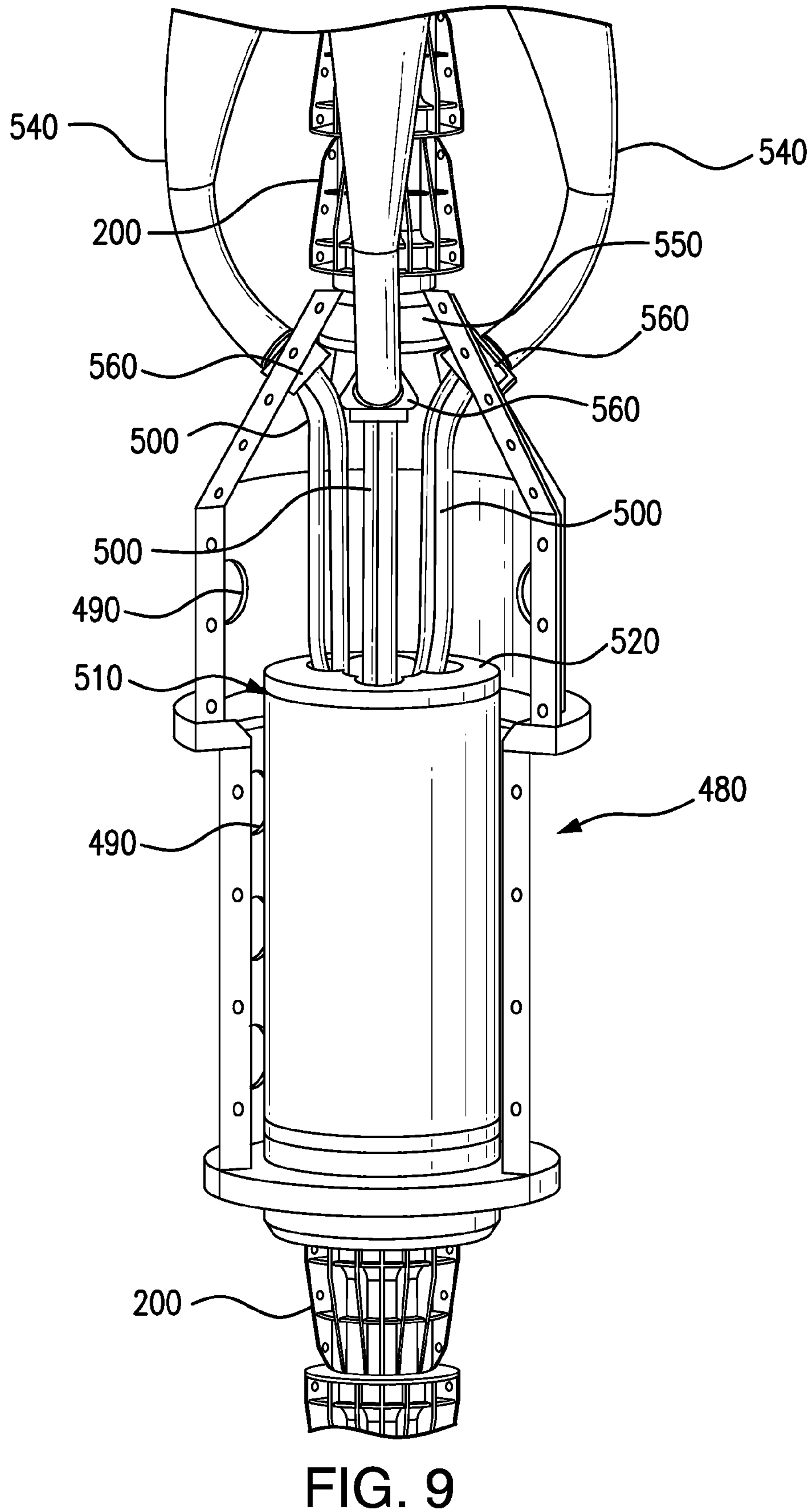


FIG. 9

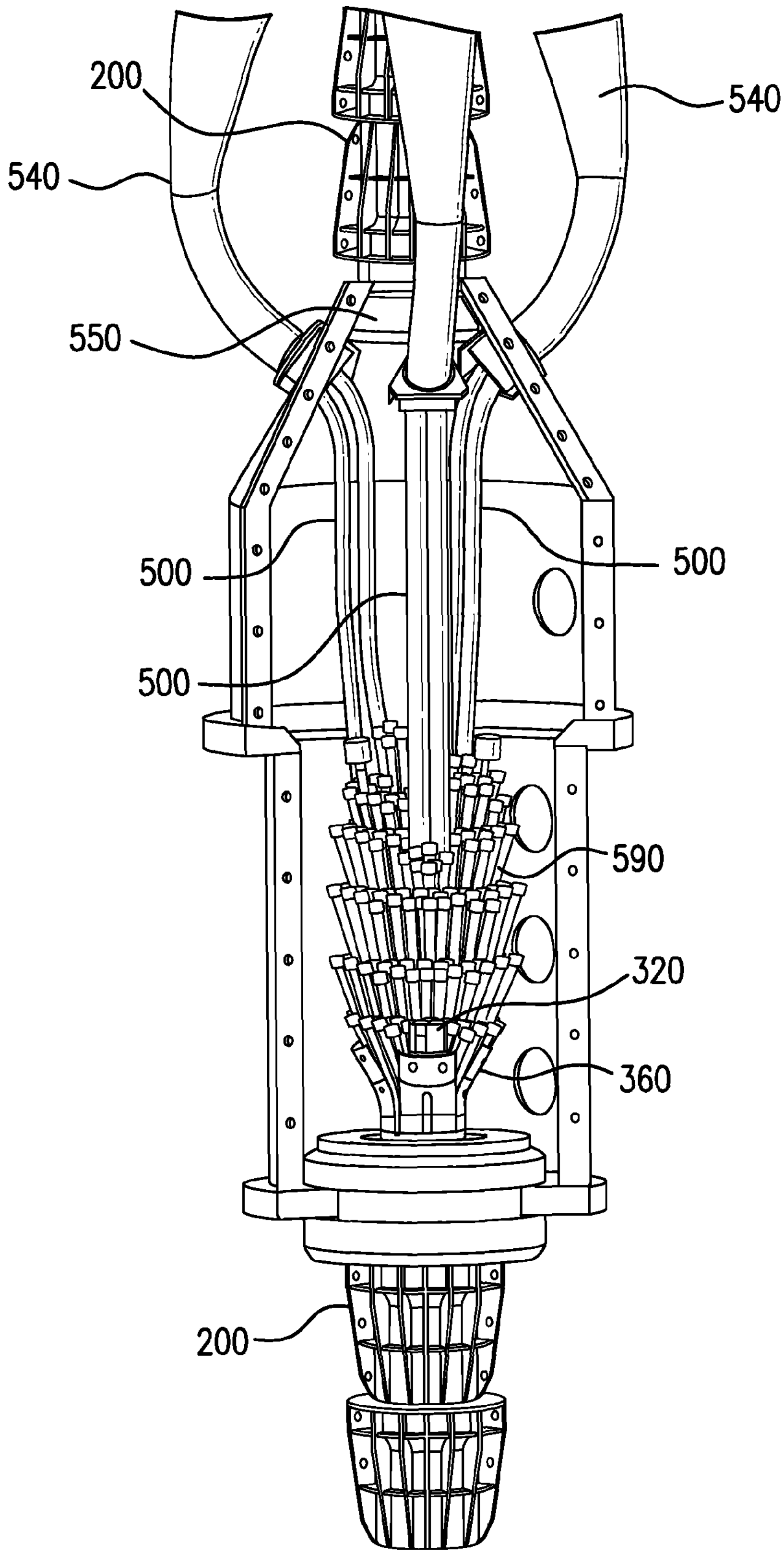


FIG. 10

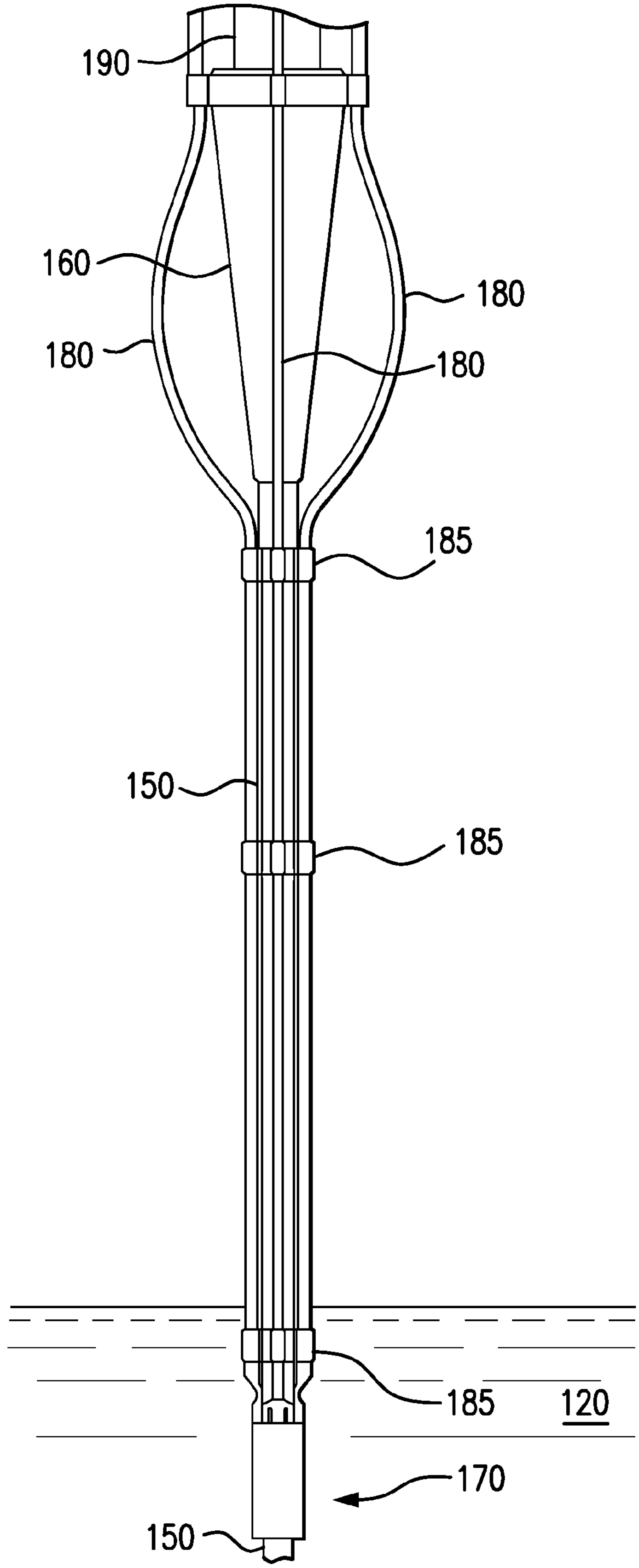


FIG. 11

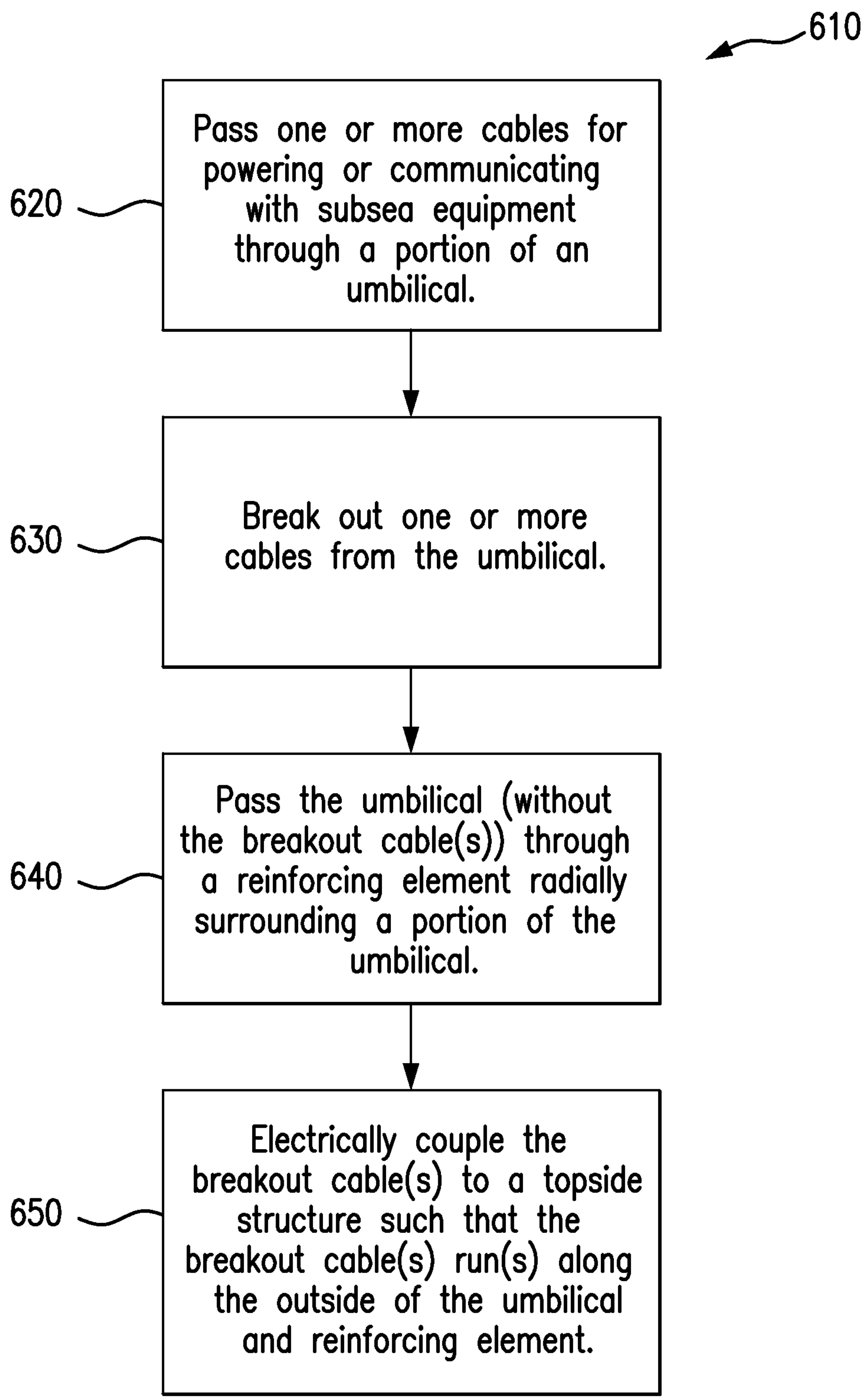

610
620
Pass one or more cables for powering or communicating with subsea equipment through a portion of an umbilical.
630
Break out one or more cables from the umbilical.
640
Pass the umbilical (without the breakout cable(s)) through a reinforcing element radially surrounding a portion of the umbilical.
650
Electrically couple the breakout cable(s) to a topside structure such that the breakout cable(s) run(s) along the outside of the umbilical and reinforcing element.

FIG. 12

SUBSEA UMBILICAL SYSTEM WITH CABLE BREAKOUT

BACKGROUND

1. Field

The present invention relates generally to subsea development projects, and more particularly to improved subsea umbilical systems with one or more cable breakouts.

2. Background

Deep-water subsea projects can refer to offshore projects located in water depths greater than around 600 feet. Such projects can be used, for example, to develop and maintain oil and gas reservoirs. Subsea well equipment used for such projects can be located on the seabed and operatively connected to a topside surface structure, such as a ship or other floating platform. In such projects, one or more umbilicals are often used to convey fluids, power, and/or send electrical and other communication signals between the surface structure and the subsea well equipment. There is a continuous need for improved subsea umbilical systems for deep-water subsea projects as well as other subsea projects.

BRIEF SUMMARY

It has been found that elements of certain umbilical systems can trap an undesirable amount heat within the system and that such heat trapping elements can negatively affect the performance of the system. For example, in some situations, medium voltage cables are unable to reach a desired amperage capacity within an umbilical due to heat trapping characteristics of elements such as a bend stiffener, I-tube, J-tube, and/or potting barrel of the umbilical system. That is, if such power cables are operated within these heat trapping elements at too high of a voltage, heat generated by the cable may build up to a level that can damage the umbilical or other elements of the umbilical system by decreasing the effectiveness of their mechanical properties, which can, in effect, reduce their life span. Certain embodiments of the present description can avoid such undesirable heat trapping characteristics by breaking one or more cables out of the umbilical, such as power cables, and not allow excessive heat build-up within the umbilical due to heat trapping elements. This can allow the power cables to be operated at higher currents, which can improve performance of the umbilical system. Because umbilical systems are often designed such that cables do not function as load carrying elements breaking these cables out of the umbilical can produce a minimal or even negligible effect on the rigidity and load bearing characteristics of the umbilical system.

In some embodiments, a subsea umbilical system can be provided for connecting a topside structure at a proximal end of the system to subsea equipment at a distal end of the system. The system can include an umbilical configured to allow one or more cables for powering or communicating with subsea equipment to be passed through at least a portion of the umbilical. The system can further include a reinforcing element radially surrounding a portion of the umbilical. The system can further include a breakout box disposed along the umbilical and configured to be positioned between the reinforcing element and the subsea equipment. The breakout box can include a breakout opening configured to allow one or more breakout cables to exit the umbilical and run along an outside of the reinforcing element to the topside structure.

In some embodiments, a method of assembling a subsea umbilical system is provided. The method can include passing one or more cables for powering or communicating with

subsea equipment through a portion of an umbilical. The method can further include breaking out the one or more cables of the umbilical. The method can further include continuing the umbilical above that point without the breakout cable or cables through a reinforcing element radially surrounding a portion of the umbilical. The method can further include electrically coupling breakout cables to electrical flying lead cables through the use of connectors so that the breakout cables are run along the outside of the reinforcing element.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate various embodiments of the present disclosure and, together with the description, further serve to explain the principles of the disclosure and to enable a person skilled in the pertinent art to make and use the embodiments disclosed herein.

FIG. **1** illustrates a diagram view of a subsea umbilical system in accordance with one embodiment of the present disclosure attached to a floating structure above a water line and to equipment on the seabed.

FIG. **2** illustrates a front perspective view of an embodiment of a subsea umbilical system.

FIG. **3** illustrates a cross-sectional view of the system of FIG. **2** along line **3**-**3** of FIG. **2**.

FIG. **4** illustrates a front perspective view of a top end of an umbilical suitable for use with the system of FIG. **2**.

FIG. **5** illustrates a front perspective view of a breakout box suitable for use with the system of FIG. **2**.

FIG. **6** illustrates a cross-sectional view of the breakout box of FIG. **5** along line **6**-**6** of FIG. **5**.

FIG. **7** illustrates an enlarged view of the cross-sectional view of FIG. **3**.

FIG. **8** illustrates a front perspective view of an embodiment of a subsea umbilical system.

FIG. **9** illustrates a front perspective view of a portion of the system of FIG. **8** with a portion of the breakout box removed for clarity.

FIG. **10** illustrates the view of FIG. **9** with the topside termination also removed for clarity.

FIG. **11** illustrates a diagram view of a subsea umbilical system in accordance with an embodiment of the present disclosure in which a bend stiffener is located above the water line.

FIG. **12** illustrates a flowchart for a method of assembling a subsea umbilical system in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

The following description is intended to convey a thorough understanding of the embodiments described by providing a number of specific embodiments and details relating to subsea umbilical systems. It should be appreciated, however, that the present invention is not limited to these specific embodiments and details, which are exemplary only. It is further understood that one possessing ordinary skill in the art would appreciate the use of the invention for its intended purposes and benefits in any number of alternative embodiments, depending upon specific design and other needs.

FIGS. **1**-**3** illustrates various views of a first embodiment of a subsea umbilical system **100**. In particular, FIG. **1** illustrates a diagram view of system **100** attached to a topside structure **110** above water line **120** and further attached to equipment **130** on seabed **140**. FIG. **2** illustrates a front perspective view of system **100**, and FIG. **3** illustrates a cross-sectional view of system **100** along line **3-3** of FIG. **2**.

System **100**, as well as other systems described herein, can be configured for use with deep-water subsea projects or other suitable subsea projects. In some embodiments, system **100** can be configured to connect at a first end to a topside structure **110**, such as a floating platform and/or floating production facility. In some embodiments, topside structure **110** can be in the form of a ship. It is appreciated that in some embodiments, system **100** can be configured to connect at a first end to a non-floating structure, such as a structure supported entirely or partially by seabed **140**. A second end of system **100** can be configured to connect to subsea well equipment **130** or other suitable equipment.

System **100** includes various components, such as an umbilical **150**, a bend stiffener **160**, a breakout box **170**, cluster conduits **180**, cluster mounts **185**, a tube **190** (shown in FIG. **1**), bend restrictors **200** (shown in FIGS. **2-3**), and electrical flying leads **205** (best shown in FIG. **3**). Each of these components is described in detail below.

As best shown in FIG. **2**, umbilical **150** passes through various components of system **100** between topside structure **110** and equipment **130**. For example, in some embodiments, umbilical **150** passes through axial passages in bend restrictors **200**, breakout box **170**, and bend stiffener **160**. Umbilical **150** is designed to connect topside structure **110** at a proximal end of system **100** to equipment **130** at a distal end of system **100**. Umbilical **150** can, for example, allow one or more cables for powering or communicating with subsea equipment **130** to be passed through at least a portion of umbilical **150**. Umbilical **150** is further described below with respect to FIG. **4**, which illustrates a cross-sectional view of umbilical **150** and depicts various cables and reinforcing elements positioned within umbilical **150**.

Bend stiffener **160** is designed to provide increased rigidity to one or more components of system **100**. Bend stiffener **160** can serve as a reinforcing element for system **100** and can be positioned along umbilical **150** so as to radially surround at least a portion of umbilical **150**. Bend stiffener **160** can, for example, have a substantially conical shape, with a top end **210** having a greater diameter than an opposite, bottom end **220**. As best shown in FIG. **3**, which is a cross-sectional view of system **100**, bend stiffener **160** can be substantially solid except for a tubular cavity **230** formed therein that extends axially between top end **210** and bottom end **220** of bend stiffener **160**. Tubular cavity **230** can be sized to securely receive umbilical **150**. For example, tubular cavity **230** can be sized to prevent umbilical **150** from undesired bending within bend stiffener **160** while still allowing umbilical **150** to be easily slid in or out of bend stiffener **160** by an operator if desired. As described above, bend stiffener **160** can function as a heat trapping element that has an undesired effect of trapping undue heat within system **100** and potentially limiting performance of one or more cables of umbilical **150**.

Breakout box **170**, which is described in further detail below with respect to FIGS. **5-6**, is designed to allow certain elements of umbilical **150**, such as pass-through elements **240**, to pass through bend stiffener **160**, while allowing other elements, such as breakout cables **250**, to break out from umbilical **150** and allow those elements to run along the outside of the bend stiffener **160**. Breakout box **170** can be disposed along umbilical **150** between heat trapping elements such (as bend stiffener **160** and tube **190**), and subsea equipment **130**. In some embodiments, breakout box **170** is located along umbilical **150** such that when umbilical system **100** is in use, breakout box **170** is located below water line **120**. It is appreciated that in some embodiments, breakout box **170** can be in another suitable position along umbilical **150**.

System **100** includes one or more electrical flying leads **205** that are electrically connected to topside structure **110** at a proximal end and electrically connected to breakout cables **250** at a distal end via electrical connectors. In some embodiments, and as shown for example in FIG. **3**, electrical connectors can be positioned outside of breakout box **170**. Electrical connectors can, for example, be configured to electrically couple terminal ends **280** of electrical flying lead cables to terminal ends **270** of breakout cables **250** passed through breakout box **170**. In some embodiments where electrical flying leads are not used, breakout cables **250** can be passed directly to topside structure **110** through cluster conduits **180**. It is appreciated that descriptions herein relating to breakout cables "running" from the breakout box to the topside structure are intended to describe breakout cables being electrically connected to topside structures. For example, this term is intended to include not only continuous uninterrupted lines between the breakout cable and the topside structure, but also electrical connections formed by multiple cable segments (such as a breakout cable segment connected to an electrical flying lead cable segment) or another suitable electrical arrangement.

Each breakout cable cluster conduit **180** is designed to securely receive one or more electrical flying leads **205** and to ensure the flying lead cables run along bend stiffener **160** in an axial direction between breakout box **170** and topside structure **110**. Each cluster conduit **180** can be substantially hollow so as to allow electrical flying leads **205** to pass therethrough. As described above, cluster conduits **180** can be used to receive cables, such as power or communication cables, or other elements that may generate unwanted heat within umbilical **150**. As such, cluster conduits **180** can be designed to withstand higher temperatures than other elements of system **100** such as umbilical **150**. Cluster conduits **180** can be designed to allow seawater to effectively cool the interior cavity thereof to prevent damage to conduit **180** or to cables **205** passed therethrough.

In some embodiments, cluster conduits **180** can run closely along an exterior surface of bend stiffener **160**. In other embodiments, such as the embodiment depicted in FIG. **3**, cluster conduits **180** can curve away from bend stiffener **160**. Cluster conduits **180** can be designed to be flexible to allow them to bend with umbilical system **100**. The shape, positioning, and construction of cluster conduits **180** can be configured in accordance with objectives and dynamic analysis requirements. As shown for example in FIG. **3**, cluster conduits **180** have substantially constant outer diameters. It is appreciated that in some embodiments, cluster conduits **180** can include non-circular outer surfaces, as well as outer surfaces that vary in dimension or shape along the axial length of the conduits.

Cluster mounts **185** are secured around top end **210** and bottom end **220** of bend stiffener **160** and are designed to securely position cluster conduits **180** around bend stiffener **160**. Cluster mounts **185** can be positioned at additional or alternative locations along umbilical system **100**. As shown for example in FIG. **2**, each cluster mount **185** can include one or more collars **290** for receiving a respective cluster conduit **180**. Each collar **290** can, for example, be positioned a uniform distance from an adjacent collar **290**. That is, for a system having three cluster conduits **180**, each collar **290** can be positioned around bend stiffener **160** approximately 120 degrees apart. Likewise, for a system having two cluster conduits **180**, the two collars **290** can be located on opposite sides of bend stiffener **160** and approximately 180 degrees apart.

Bend restrictors **200** are provided at various locations of umbilical **150** in order to restrict undesired bending of umbilical **150** at these locations. For example, as depicted in FIG. **2**, a first set of bend restrictors **200** can be positioned just below breakout box **170**, with a second set of bend restrictors **200** positioned just above breakout box **170**. It is appreciated that additional or fewer bend restrictors **200** can be provided along umbilical **150**. Likewise, one or more bend restrictors **200** or other such restrictors can be positioned around other components of system **100** to restrict undesired bending of system **100**.

Tube **190** (shown in FIG. **1**) can be in the form of an I-tube, J-tube, or other similar tube. Tube **190** can, for example, provide increased rigidity, protection, and/or serve other functions for system **100**. Tube **190** is coupled at one end to bend stiffener **160** and at another end to topside structure **110**. Tube **190** radially surrounds a section of umbilical **150**. Tube **190** includes a tubular cavity to allow umbilical **150** or elements of umbilical **150** to pass through tube **190**. As described above, like bend stiffener **160**, tube **190** can function as a heat trapping element by undesirably trapping heat within system **100**, which may limit performance of one or more elements of umbilical **150**.

FIG. **4** illustrates an embodiment of an umbilical **150** suitable for use with subsea umbilical system **100**. As described above, umbilical **150** is designed to allow one or more cables **300** for powering or communicating with subsea equipment **130** to be passed through at least a portion of umbilical **150**. It is appreciated that umbilicals providing additional or lesser functionality may be suitable for use with system **100**.

In some embodiments, cables **300** can, for example, be cables for powering or communicating with subsea equipment **130**. One or more of cables **300** of umbilical **150** can be power cables, such as medium voltage power cables. In some embodiments, one or more of cables **300** of umbilical **150** can be communication cables configured to transfer data between topside structure **110** and subsea equipment **130**. It is appreciated that medium and higher voltage power cables may be especially well suited for use in system **100** as such cables tend to generate greater heat than a lower power cable or a data cable. Although FIG. **4** depicts the use of multiple power cables **300**, it is appreciated that in some embodiments, umbilical **150** may include more or less power and/or communication cables than illustrated.

Umbilical **150** further includes multiple types of inserts and elements. For example, umbilical **150** includes inserts **320** which can be designed to provide increased impact and crush resistance for umbilical **150**, while still allowing one or more elements the freedom to react under axial and bending load conditions. Inserts **320** can be designed to position elements of umbilical **150** in a desired location. Umbilical **150** can include load carrying elements such as a cluster of reinforcing rods **340** or a single reinforcing rod **350** positioned within an opening in insert **320**. Load carrying elements can be made from carbon fiber, steel, or another suitable material. It is appreciated that in some embodiments, umbilical **150** can be designed so as not to include an insert **320** or load carrying elements.

Umbilical **150** further includes a protective sheath **360** that surrounds the various interior elements of umbilical **150**. The interior surface of sheath **360** forms around umbilical **150** extending between an opening at a distal end of umbilical **150** and an opening at a proximal end of umbilical **150**. Sheath **360** can include one or more openings formed in a peripheral surface of sheath **360** to allow one or more breakout cables **250** or other elements to break out from umbilical **150**.

FIGS. **5** and **6** illustrate various views of breakout box **170**. In particular, FIG. **5** illustrates a front perspective view of breakout box **170** and FIG. **6** illustrates a cross-sectional view of breakout box **170** along line **6-6** of FIG. **5**. As depicted in these figures, breakout box **170** is formed by an upper portion **370**, a central portion **380**, and a lower portion **390**. An upper flange **400** is used to connect upper portion **370** to central portion **380**, whereas a lower flange **410** is used to connect central portion **380** to lower portion **390**. Bolts, welding, or other fastening means can be used to securely connect the various portions.

Central portion **380** is substantially hollow and includes multiple breakout openings **420** for permitting breakout cables to exit from breakout box **170**. Upper and lower portions **370** and **390** are substantially solid with cavities formed therein to allow umbilical **150** to axially pass between an upper opening **450** and lower opening **460** in breakout box **170**. The outer sheathing **360** and inserts **320** can be removed as needed between the upper and lower openings to allow breakout cables to get free of the umbilical then repaired upon final assembly. The main load carrying elements should remain as straight as possible through this section and protected as needed. Breakout box **170** can further include one or more ventilation holes **490** formed therein.

FIG. **7** illustrates an enlarged view from FIG. **3** of breakout box **170**. As depicted in FIG. **7**, breakout cables **250** extend through a breakout opening in sheath **360** and inserts **320** of umbilical **150** and pass through breakout opening **420** formed in breakout box **170**. As shown in this view, although breakout cables **250** are broken out of umbilical **150**, the remaining elements of umbilical **150** (referred to herein as pass-through elements **240**), continue through breakout box **170** and are eventually passed through bend stiffener **160** and tube **190** and eventually to topside structure **110**.

FIG. **8** illustrates a second embodiment of a subsea umbilical system **470**. System **470**, like system **100** described in FIG. **1**, can, for example, be configured for use with deep-water subsea projects or other suitable subsea projects. System **470** can include substantially similar elements as system **100**, such as umbilical **150**, bend stiffener **160**, electrical flying leads **205**, cluster conduits **180**, cluster mounts **185**, and bend restrictors **200**. System **470** can additionally include a modified breakout box **480** that allows for the tensile load of the umbilical to be carried by the shell of the breakout box **480**.

FIG. **9** illustrates an interior view of a portion of system **470**, with a portion of breakout box **480** removed for clarity. As shown in FIG. **9**, similar to breakout box **170**, breakout box **480** is substantially hollow and includes multiple breakout openings **560** for permitting breakout cables **500** to exit breakout box **480**. Breakout openings **560** can be provided near the top end of breakout box **480** or at another suitable location. Like breakout box **170**, breakout box **480** can additionally include one or more ventilation holes **490** formed therein.

System **470** further includes a topside termination **510** that is load bearing and protects various elements of umbilical **150** within breakout box **480**. Breakout box **480** provides for hang-off of the umbilical topside termination **510** and transfers the tensile load from the umbilical elements and topside termination to a strength members only umbilical above that point. The top surface **520** thereof allows breakout cables **500** to exit from topside termination **510**.

System **470** can include one or more electrical flying leads **205** that are electrically connected to topside structure **110** at a proximal end of flying lead **205** and electrically connected to breakout cable **500** at a distal end via electrical connectors, which is the same method used in system **100**. System **470** can further include a second set of cluster conduits **540** that are configured to allow breakout cables and flying lead cables to pass therethrough. System **470** can be used with umbilicals containing power and communication cables and/or non-load carrying hydraulic tubes. In some embodiments, system **470** is designed such that it would not be used where hydraulic steel tubes carry a portion of the load. In such an embodiment, such a configuration would allow separation of strength carrying elements inside the breakout box. Such a configuration could create standardized upper umbilical/bend stiffener sections each with a load range that can be used for multiple umbilical projects. The attachment point of this upper umbilical section to breakout box **480** is shown as load bearing component **550**.

FIG. **10** illustrates the view of FIG. **9** with topside termination **510** additionally removed for clarity. As shown in FIG. **10**, elements **590** of the umbilical flare out within topside termination **510**. These flared elements **590** are secured within topside termination **510**, which hangs-off inside breakout box **480** as shown in FIG. **10**. Flared elements **590** can include certain cable reinforcing elements, reinforcing members, or other elements that do not need to be extended past breakout box **480**. Flared elements **590** in the form of unused power or data cables can be capped to prevent undesired signal transmission. System **470** can further include flared outer sheathing **360** and inserts **320**.

FIG. **11** illustrates a diagram view of a subsea umbilical system in which a bend stiffener of the system is located above the water line. For the sake of convenience, FIG. **11** is labeled with elements from system **100** described herein. However, it is appreciated that one or more other systems described herein can position a bend stiffener or other element of the system above the water line.

FIG. **12** is a flowchart for a method **610** of assembling a subsea umbilical system. For the sake of convenience, method **610** references elements from system **100** described herein. However, it is appreciated that one or more steps of method **610** can be performed on other suitable systems, such as for example, system **470**.

Method **610** includes a step **620** of passing one or more cables **300** for powering or communicating with subsea equipment through a portion of umbilical **150**. As described for example with respect to FIG. **4**, additional elements, such as load carrying elements **340** and **350**, can be passed through umbilical **150**.

Method **610** further includes a step **630** of breaking out a breakout cable **250** from the one or more cables **300** of umbilical **150**. It is appreciated that an operator may choose, for example, to break out only cables or other elements that do not contribute to the load carrying capacity of umbilical **150**. In some embodiments, breakout cables **250** can include every power or data cable within the umbilical, such that only load carrying elements like **340** and **350** are passed through the reinforcing elements (e.g., bend stiffener **160** and/or tube **190**).

Method **610** further includes a step **640** of passing umbilical **150** (without breakout cables **250**) through a reinforcing element. In some embodiments, breakout cables **250** can be cut with the subsea side terminating into connectors mounted on breakout box **170**. Any remaining cable length of breakout cables **250** running to topside structure **110** can merely act as filler inside umbilical **150**. In some embodiments, umbilical **150** (without breakout cables **250**) is installed on structure **110**, and flying leads **205** are lowered through holes in structure **110** around tube **190** and bend stiffener **160**.

Method **610** further includes a step **650** of electrically coupling breakout cables **250** to topside structure **110** such that breakout cables **250** are run along the outside of a reinforcing element. In some embodiments, step **650** can be performed by a diver electrically connecting flying leads **205** to breakout cables **250** extending from breakout box **170**. In some embodiments, step **650** can include coupling breakout cables **250** to a flying lead **205** that runs along the outside of a reinforcing element. In some embodiments, step **650** can include attaching breakout cables **250** and flying lead cables **205** to electrical connectors (such as electrical connectors **270** and **280**) and joining the electrical connectors together outside of breakout box **170**.

All numbers in this description and figures indicating amounts, ratios of materials, physical properties of materials, and/or use are to be understood as modified by the word "about," except as otherwise explicitly indicated. The choice of materials for the parts described herein can be informed by the requirements of mechanical properties, temperature sensitivity, moldability properties, or any other factor apparent to a person having ordinary skill in the art. For example, one or more of the parts described herein (or a portion of one of the parts) can be made from suitable metals, rubber, alloys, plastics, and/or other suitable materials.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

Additionally, while the processes described above and illustrated in the drawings are shown as a sequence of steps, this was done solely for the sake of illustration. Accordingly, it is contemplated that some steps may be added, some steps may be omitted, the order of the steps may be re-arranged, and some steps may be performed in parallel.

What is claimed is:

1. A subsea umbilical system for connecting a topside structure at a proximal end of the system to subsea equipment at a distal end of the system, the umbilical system comprising:

an umbilical configured to allow one or more cables for powering or communicating with subsea equipment to be passed through at least a portion of the umbilical;

a reinforcing element radially surrounding a portion of the umbilical; and

a breakout box disposed along the umbilical and configured to be positioned between the reinforcing element and the subsea equipment,

wherein the breakout box includes a breakout opening configured to allow one or more breakout cables to exit the umbilical and run along the outside of the reinforcing element to the topside structure.

2. The umbilical system of claim **1**, further comprising:

a breakout cable for powering or communicating with subsea equipment, the cable being passed through a portion of the umbilical that is distal to the breakout box and is run along an outside of the reinforcing element to the topside structure.

3. The umbilical system of claim **2**, wherein the cable is a medium voltage power cable for powering subsea equipment.

4. The umbilical system of claim 2, wherein the cable is a data cable configured to transfer data between the topside structure and the subsea equipment.

5. The umbilical system of claim 2, wherein the umbilical includes one or more load carrying elements in addition to the one or more cables for powering or communicating with subsea equipment.

6. The umbilical system of claim 2, wherein the one or more breakout cables include every power or data cable within the umbilical and only load carrying elements are passed through the reinforcing element.

7. The umbilical system of claim 1, further comprising:

a conduit running along an outside of the reinforcing elements, the conduit being configured to allow one or more breakout cables to pass through the conduit.

8. The umbilical system of claim 1, further comprising:

three conduits that run along an outside of the reinforcing element, each conduit being configured to allow one or more breakout cables to pass through a respective conduit,

wherein the three conduits are positioned approximately 120 degrees apart around the reinforcing element.

9. The umbilical system of claim 1, further comprising:

electrical flying leads that are configured to be connected to the topside structure at a proximal end of the flying lead and electrically connected to the breakout cable at a distal end of the flying lead via an electrical mating connector.

10. The umbilical system of claim 9, wherein the electrical mating connector is integrated into the breakout box, the electrical mating connector being configured to electrically couple a terminal end of the breakout cable located within the breakout box to a terminal end of the flying lead cable located outside the breakout box.

11. The umbilical system of claim 9, wherein the electrical mating connector is positioned outside of the breakout box, the electrical mating connector being configured to electrically couple a terminal end of the breakout cable passed through the breakout box to a terminal end of the flying lead cable located outside the breakout box.

12. The umbilical system of claim 1, wherein the umbilical includes a sheath having an opening formed in a peripheral surface thereof that is sized to allow one or more cables to exit from the umbilical through the opening.

13. The umbilical system of claim 1, wherein the reinforcing element is in the form of a bend stiffener, I or J tube, and/or topside termination.

14. The umbilical system of claim 1, wherein the breakout opening of the breakout box is formed in a peripheral surface of the breakout box.

15. The umbilical system of claim 1, wherein the reinforcing element is configured to be located below the water line when the umbilical system is in use.

16. The umbilical system of claim 1, wherein the reinforcing element is configured to be located above the water line when the umbilical system is in use.

17. A method of assembling a subsea umbilical system, the method comprising:

passing one or more cables for powering or communicating with subsea equipment through a portion of an umbilical;

breaking out one or more cables from the umbilical;

passing the umbilical without the breakout cable(s) through a reinforcing element radially surrounding a portion of the umbilical; and

electrically coupling the breakout cable to a topside structure such that the breakout cable is run along an outside of the reinforcing element.

18. The method of claim 17, wherein electrically coupling the breakout cable to a topside structure such that the breakout cable is run along an outside of the reinforcing element includes coupling the breakout cable to an electrical flying lead that runs along the outside of the reinforcing element.

19. The method of claim 18, wherein the breakout cable is connected to a first end of an electrical connector on a first side of a breakout box and the flying lead is connected to a second end of the electrical connector on a second side of the breakout box.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,091,146 B1
APPLICATION NO. : 14/257556
DATED : July 28, 2015
INVENTOR(S) : John Whiddon and Heith Little

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Drawings

Replace Figures 3 and 10 with enclosed replacement sheets.

In the Specification

At column 1, line 63, replace "more breakout cables to exit the umbilical and run along an" with -- more breakout cables to exit the umbilical and run along and --.

At column 3, line 24, replace "110 and equipment 130. For example, in some embodiments," with -- 110 and subsea well equipment 130. For example, in some embodiments --.

At column 3, line 28, replace "end of system 100 to equipment 130 at a distal end of system" with -- end of system 100 to subsea well equipment 130 at a distal end of system --.

At column 3, line 30, replace "cables for powering or communicating with subsea equip-" with -- cables for powering or communicating with subsea well equip- --.

At column 3, line 64, replace "such (as bend stiffener 160 and tube 190), and subsea equip-" with -- (such as bend stiffener 160 and tube 190), and subsea equip- --.

Signed and Sealed this
Ninth Day of February, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office

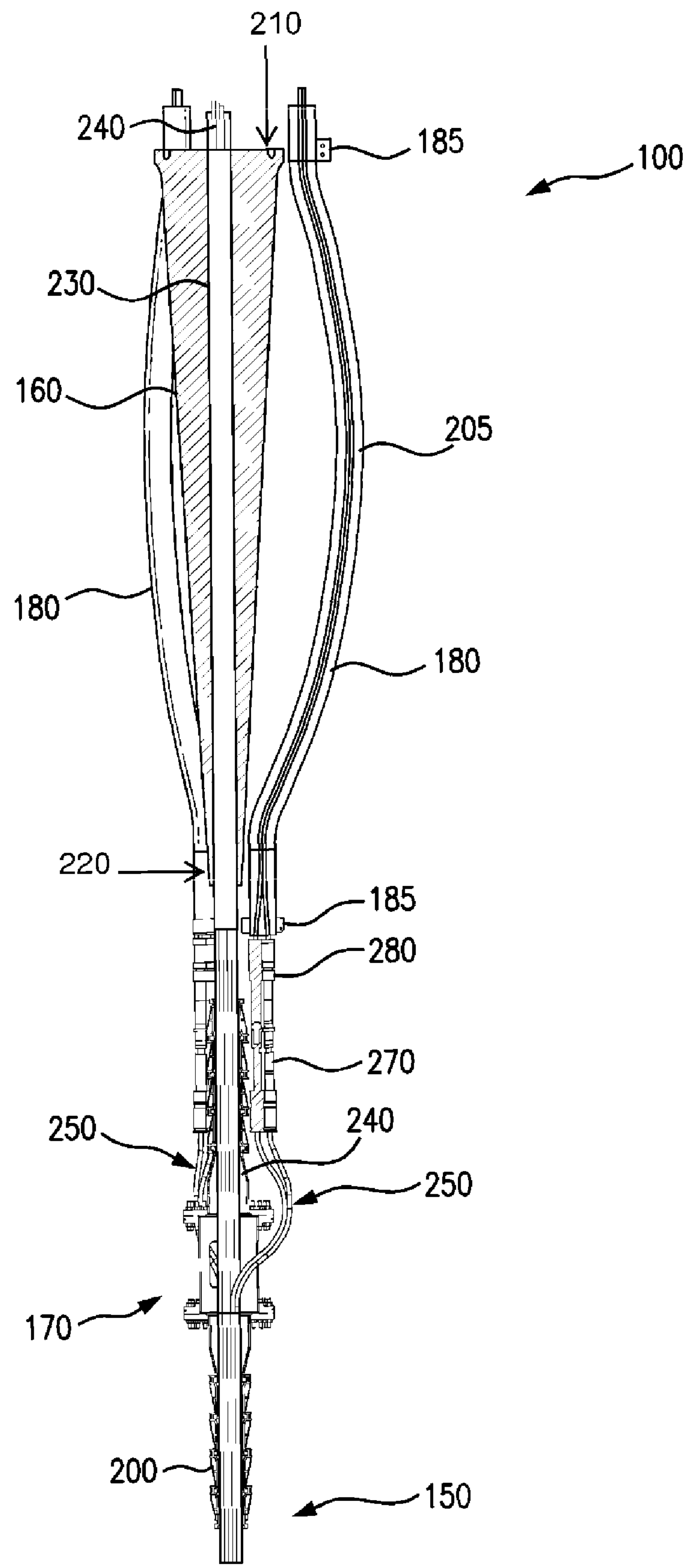

210
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FIG. 3

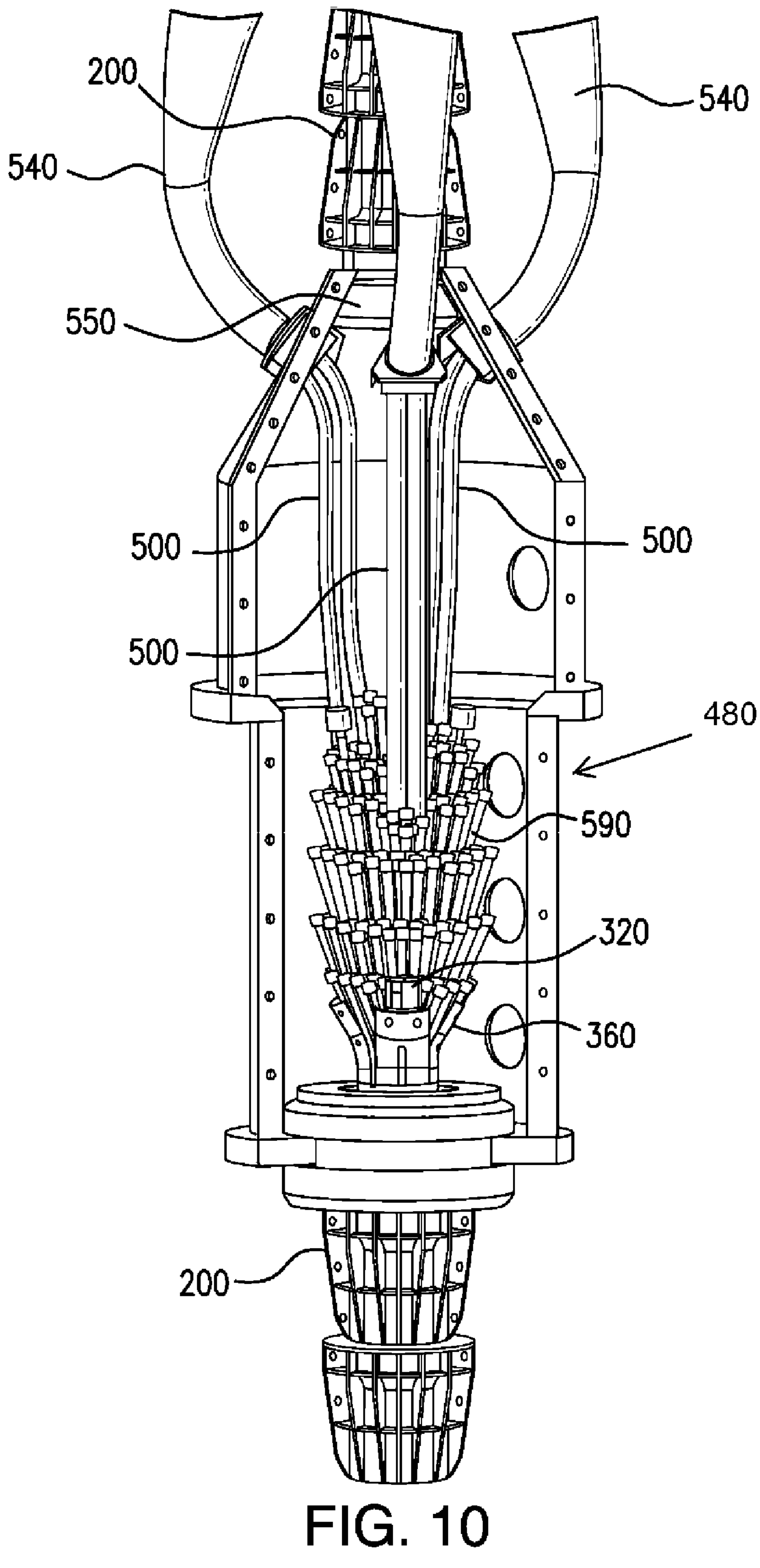

FIG. 10